City of Corvallis Salmon Response Plan

Chapter 4. Methodology

Prepared for:

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Disclaimer

The authors have attempted to replace all references to Squaw Creek with the creek's new name, Dunawi Creek. This includes replacing the creek's full name as well as changing Squaw Creek Reach reference labels to indicate Dunawi Creek.

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CHAPTER 4. METHODOLOGY

INTRODUCTION

The purpose of this chapter is to describe the project's scientific methodology. The following elements are addressed in the chapter:

- Description of the evaluation methodology;
- Process/steps to determine the baseline conditions (e.g., existing data collection, field research, interviews, geographic information systems, etc.); and
- Quantification/calculation factors and the rationale that justifies each numerical score so reviewers understand how a particular score is calculated and can be replicated.

SCIENTIFIC BASIS FOR STUDY

As identified in Chapter 2, the ESA requires a strong scientific basis for methodology used in the evaluation process. It was critical that the data collection and analysis carefully follow scientific principles.

The methodology used in the analysis was developed in collaboration with the NOAA Fisheries. A series of meetings were held between the City of Corvallis, their project consultants and NOAA Fisheries in the Spring of 2001. The purpose of the meetings was to develop a methodology that would be acceptable to NOAA Fisheries. The methodology included the data elements that were to be collected, the data collection procedures, the categorization of the data, the evaluation/interpretation of the data collected and the City's proposed scoring for ranking City activities and citizen behavior in the pathways/effects analysis.

There was some concern on the part of NOAA Fisheries that any quantitative metric, no matter how carefully it was calculated, runs the risk of "hiding" or "masking" the rationale for a particular score. NOAA Fisheries recommended that any scoring methodology had to be fully explained in the report. The City agreed that all scoring methods would be carefully outlined so the reader would understand the scoring rationale and methodology.

Based on these meetings, the Corvallis project team prepared and submitted a technical memorandum (April 18, 2001) that outlined in detail the scientific approach to the methodology. The methodology incorporated the Oregon Department of Fish and Wildlife (ODFW) *Aquatic Inventories Project, Stream Survey Methods* and methods that were developed in discussions with NOAA Fisheries, as well as an approach to assessing pathways/effects for City services and citizen behavior. The technical memorandum was reviewed and approved by NOAA Fisheries (Appendix 2).

METHODOLOGY DESCRIPTION

The following is a brief overview of the methodology developed for the data collection, analysis, and pathways/effects analysis and scoring.

Baseline Conditions Habitat Assessment

The stream habitat inventory assessed the aquatic habitat of streams and gathered baseline data for the purpose of future monitoring activities. The data were collected according to protocols set forth in the ODFW *Aquatic Inventories Project, Stream Survey Methods*.

The inventory protocol had two phases. Phase one consisted of surveying existing fish habitat at selected reaches by estimating and measuring the physical dimensions of individual habitat units (pools, riffles, etc.) and characterizing important features (i.e., substrate, fish cover, and large wood) within each unit. Phase two involved taking detailed, site-specific data of channel morphology and substrate composition to establish a baseline for future monitoring activities. Field visits were also made to assess any barriers to fish movement in any of the streams.

Sequoia, Dixon, Oak, Dunawi, and Stewart Creeks were assessed for barriers to anadromous fish movement. Dry Creek, Ryan Creek, and the Mill Race were investigated but not selected for the barrier assessment because they were determined not to have the necessary hydraulic connection to support chinook salmon habitat. No barriers were found on the Mary's River or Stewart Slough. Oak Creek had a box culvert that forms a barrier just above its confluence with the Mary's River, and two dams on the Oregon State University (OSU) Campus at the Entomology Farm (between 30th and 35th Streets) and a pop-up dam used for summer irrigation (between 53rd and Harrison Streets). Dunawi Creek had a retaining wall constituting an impassable channel barrier at Brooklane Drive, and two box culverts at its 35th Street and West Hills Road crossings, likely impassable except to adult anadromous fish at high flows. Dixon Creek had a baffled cement box culvert at its Highway 20 crossing (6 meters upstream from the confluence with the Willamette). Higher water levels in the Willamette or removal of the boulders would make the culvert passable. It also had double box concrete culverts at its 3rd and 4th Street crossings and its Buchanan Avenue crossing. The very shallow water at low flows and high velocities at moderate and high flows create severe passage problems.

The riparian condition analysis (RCA) process was developed to inventory riparian area conditions for the ESA stream habitat assessment. The RCA process uses an assessment system that results in a score indicting how well the riparian unit functions as fish habitat. The process documents habitat characteristics such as stream size, vegetation type, and the degree of habitat modification by development. It provides scores for a set of condition modifiers, or factors, that influence fish habitat. The initial assessment was made using aerial photograph interpretation and ground-truthed with observations made during stream habitat surveys.

The process was hierarchical, with the first division made as to the nature of the riparian system; lotic (flowing) or lentic (standing). The second level (class) concerned dominant ground cover and had the following categories: forested, shrub-sapling, herbaceous, and developed. The next level (subclass) further subdivided the previous one, and described in more detail the various subclasses.

Table 2 outlines the classification system used to label the GIS riparian polygons. The information encoded in each polygon classification can be analyzed to produce a range of possible scores that can be assigned for the individual fish habitat functions. The scores are derived by GIS analysis of the mapped and classified polygons.

Table 2. Riparian Classification System

Riparian System	Class	Subclass
Lotic (Lt)[1] riparian area adjacent to stream or river or Lentic (Ln) riparian area adjacent to lake or pond	Forested (FO) (at least 30% forest canopy)	evergreen (eg)
		deciduous (de)
		mixed (mx) (at least 30% each eg and de)
	Shrub-sapling (SS) (at least 30% shrub or sapling cover, less than 20 feet high)	evergreen (eg)
		deciduous (de)
		mixed (mx) (at least 30% each eg and de)
	Herbaceous (HE)	agricultural (ag) (crops, pasture)
		turf(tf)
	Developed (DV)	residential (res)
		commercial/industrial (c/i)
		infrastructure (inf)
		mixed (mx)

1 - Modifiers may be used with Lotic to designate approximate stream size and channel condition

A simple example of a polygon classification is LtFOde. This denotes a deciduous (de) forested (FO) riparian area adjacent to a stream (Lt). Modifiers may be added to increase the density of information as necessary. Canopy cover, cover of shrubs or saplings, or amount of the polygon covered with developed areas were similarly quantified and documented as modifiers to the subclass category.

CORVALLIS PATHWAYS ANALYSIS

Pathways Descriptions

The pathways used in this report combine the concept of take with the assessment of properly functioning condition, and use it to evaluate City activities. Pathways are the links or connections between an activity and the chinook salmon habitat. It is through the pathway that an activity may impact the habitat.

There are five pathways that tie an activity and that habitat together. They are the following:

- Channelization/Instream Habitat
- Impervious Surface
- Riparian Areas
- Barriers
- Contaminants

A brief description of each pathway, as it is used in the analysis follows. How the methodology is applied to evaluate the pathways is provided in the next section.

Channelization/Instream Habitat

As encroachment occurs in floodplains, streams become stormwater conduits. When encroachment is combined with the removal of large woody debris (LWD) from the channel, down-cutting increases (incision), stream bottom gradient increases, lateral erosion decreases, and the stream resembles a straight channel. Loss of floodplain and restriction of channel cause loss of off-channel habitat. Channelization itself causes increased velocity and increased down-cutting erosions. It severs connections between streamflow and groundwater, causes problems in the hyporheic zone, and increases difficulty of fish spawning and rearing by depriving them of oxygenated upwelling water. Channelization also degrades instream cover, off-channel and other refugial habitat, riparian conditions, hydrologic connectivity, food resources, substrate, and instream habitat quantity, diversity, and quality.

Impervious Surface

Properly functioning condition consists of flows governed by infiltrated groundwater, overland flows, and source flows (e.g., springs, lakes, etc). This condition means that system hydrographs have fewer peaks over a longer period of time (i.e., bankfull flows occur on the order of two per five-year interval). Systems with heavy impacts can have these events several times in a year.

An increase in impervious surface can upset a stream's equilibrium as it leads to greater amounts of overland flow, as opposed to infiltrated groundwater, as one of the sources of water in the stream. Overland flows create larger water volumes in the stream in a shorter period of time. Runoff from impervious surfaces can also increase instream erosion as the stream moves toward a new equilibrium based on the new flow regime.

The results of impervious surface can lead to loss of instream habitat features (e.g., under-bank cover) through erosion and transport of LWD downstream. Initially, it also increases the amount of fine sediment that is transported downstream.

If left uninterrupted by other flow regime changes, it is possible that a stream will attain a new equilibrium within approximately 20 years even with the initial increase in impervious surface. As it nears its new equilibrium, the percentage of fine sediments in the substrate decreases.

The principal effect of the increased flows is to widen the channel. This occurs because the stream must accommodate these greater flows. Bankfull width increases and pools fill in. Streamflow slows and temperature increases, due to the slower passage, loss of riparian shading, and greater surface area to be heated. Continued erosion causes the loss of overhanging cover in the pool areas. Increased sedimentation and the subsequent slowing of flows and filling of pools by finer sediments causes a loss of spawning and rearing habitat. As the channel reaches equilibrium, the higher flows flush the finer sediments away leaving coarser sediments, which may be better for spawning activities. However, spawning activity would likely be diminished if the connection between the groundwater flows and surface flows is severed as the result of changes in the hyporheic zone due to the increase in impervious surface. The higher flows may also wash fish away and the lower flows may strand them in summer when rearing is important.

The chief pathway for this change is increased impervious surface contributing to greater surface runoff and less infiltration. This leads to higher flows and a "flashier" hydrograph. Secondary pathways could be the loss of riparian habitat and decreased groundwater flows; the latter as at least the partial result of reduced infiltration of stormwater. Increased impervious surface is the direct result of increased development of all types. The more concentrated the development, the greater the amount of impervious surface. When impervious surface cover becomes approximately 10% of the total land surface, stream habitat begins to suffer. If a stream's flow reaches a new equilibrium given the increased impervious surface coverage, riparian issues become more critical to the preservation of chinook salmon habitat.

Riparian Areas (Buffers)

Properly functioning condition consists of buffer widths, continuity, and structure sufficient to provide streambank erosion protection, LWD, filtration of overland flow, and shading. Densely vegetated riparian areas act as filters for contaminants and nutrients, as well as infiltration areas to regulate flows. Riparian areas provide LWD, an important contributor to instream habitat structure and formation. They also provide shade for the adjacent stream, reduce bank failure, and create instream bank cover for fish.

Riparian areas function to preserve or enhance water quality by regulating temperature and by filtering contaminants, sediments, and nutrients. Temperature plays a critical role in the regulation of fish physiological function. The Clean Water Act sets temperature limits for cold-water fish species (e.g., salmonids) through the Beneficial Use portion of the Act that authorizes and justifies the Section 303(d) listings and total maximum daily load (TMDL) limits. The presence of vegetation serves to create cool-water refugia microclimate areas for fish to escape generally warmer temperatures in other portions of the stream. Riparian areas regulate temperature by shading the stream. Tall conifers perform this function best, but any woody or even tall herbaceous vegetation along the streambank or on a south slope will also do this, depending on the size of the stream. Elements important to this function include vegetation type and height, stream width, stream orientation and stream flow.

Contaminants not only include pollutants, but also sediments, nutrients, and streambank erosion. Recent research suggests that grassy buffer strips may filter out contaminants better than woody vegetation, but any vegetation will do this at some level. Aside from acting as a filter, vegetation also binds the streambank, reducing erosion. Important elements for this function are vegetation type, buffer width, riparian continuity, and slope.

Riparian areas influence fish habitat through many other significant elements, including the temperature, the contaminants, and vegetation type. Temperature and filtration effects are mentioned above, as is the securing of the streambanks. This reduces the collapsing of the banks, allowing the stream to undercut them and thereby creating fish habitat. This undercut bank habitat also may serve as a cool-water refuge. The securing of banks is an under-appreciated feature of grassy riparian zones. The prevention of instream erosion and the filtration of sediments keep important habitat features, such as spawning gravels and rearing pools, from silting in. This prevents mortality of the eggs from anoxia. It also maintains pool depth, which prevents summer mortality. Large wood serves an important role in stream habitat modification by creating pools and other instream habitat features, as well as substrate for invertebrates, which are potential food sources.

Changes in the riparian condition cause an increase in instream erosion and an eventual loss of habitat structure and diversity. The increased Horton (overland) flow of water also contributes more sediment and contaminants. Other riparian condition pathways are insufficient buffer size and structure, which diminish the functions of infiltration and filtration. If the riparian zone consists of lawns or manicured grasses, it can act as impervious surface. The presence of large wood is diminished by lowered riparian connectivity, as is the structure of the riparian zone. A zone with no large trees will contribute no LWD to the stream channel. Riparian areas with shrubs or young trees provide less shade function to a stream. Grasses shade even less and manicured grasses provide no shade function. Any vegetation on the bank will provide protection against erosion, although quality varies.

Barriers

Barriers to fish movement include such structures as culverts and pop-up dams. Culverts create an environment where flows become considerably more powerful, but also may serve as low-flow barriers to movement. Dams without fish passage serve as blockage to movement during all flow regimes. Barriers are critical as they do not allow adult fish upstream access to spawning habitat, they do not allow juveniles access to rearing and refugia, and they do not allow juveniles downstream passage.

Contaminants

Contaminants in the water may have a direct effect, through toxicity to one or more life stages of the fish or other elements of the food web (as measured by field discovery and/or lab testing), or indirect effects, such as sublethal impacts on growth and vitality. These effects are difficult to separate from background individual variation within a population, as well as from seasonal changes. They can, however, be highly important in the long-term survivability of the population, as their impact tends to be on lifetime reproductive output, usually through effects on growth, reproduction, sensory or motor functions, or food supply.

As can be seen by the complexity of the various pathways, channelization, impervious surface, and riparian buffers have the most diverse potential for impacts leading to take. In order to determine the impact of the City and set the habitat baseline for these impacts, the stream condition in the project area must be assessed and the nature and extent of current and future City regulatory and infrastructure activities must be measured.

GUIDELINES FOR USING THE PATHWAY ANALYSIS WORKSHEET

Purpose

The protocols describe and provide guidance and consistency in evaluating Corvallis Land Development Code, Comprehensive Plan and other plans and policies using the Pathway Analysis Worksheet (See Appendix 3 for example worksheets from the Baseline Database and the Weighted Pathways Database). The Pathway Analysis Worksheets have been created to systematically analyze and evaluate City documents and activities.

Process

The process requires:

1. Screening the code, plan or policy text for sections that may impact stream habitat.
2. Citing and documenting the language and relevant information.
3. Characterizing the pathway (means by which an impact occurs).
4. Analyzing the text.
5. Scoring and documenting the results.

What follows is a step-by-step description of the process for performing regulatory analysis using the Pathway Analysis Worksheet.

Step 1: Screening

The first step involves screening the document (e.g., Land Development Code, Comprehensive Plan, etc.) for sections that may have positive or negative effects on stream habitat, or where a clear connection or pathway may exist but the effects are deemed neutral. When screening the key question that should be considered is:

> Key Question: Could the subject of the section (actions, uses, activities, behaviors, or authorities, etc.) have an impact on protected fish or stream habitat?

If a nexus can be discerned, then a record for the section should be entered in the worksheet.

Step 2: Citation and Documentation

If a record is warranted, the second step is to fill out Columns 5 through 8 in the worksheet. These items must provide a clear reference from the document item to the line item in the worksheet. The "Description" column includes either a synopsis of the language within the section, a paraphrase, or an excerpt. If more than one document will be included in the worksheet also add a document identification code in Column 1.

Step 3: Characterize the Pathway

The third step is to characterize the pathway by filling out Columns 2, 3 and 4 in the worksheet. This involves:

1. Identifying the pathway or conveyance as either:
    a. Channelization,
    b. Barrier,
    c. Buffer,
    d. Contaminants, or
    e. Impervious Surfaces;
2. Identifying the type of impact as either Direct or Indirect; and
3. Ascribing a positive negative or neutral influence to the pathway.

Step 4: Analyze the Code Section, Plan, or Policy

Step four, Analysis of the Land Development Code (LDC) Section, involves clarifying and isolating the relevant connection between the substance of the code documented in the Description, the Pathway/Conveyance, and the effect on stream habitat.

If necessary, notes, calculations, diagrams, and detailed rationale can be documented.

Step 5: Scoring, Discussion, and Justification

Having clarified and isolated the pathway identified in the LDC section, it can now be scored based on the following columns in the worksheet:

Filter: This column provides a useful way to categorize the language used in the code section (Definite or Conditional, Quantifiable or Non- Quantifiable).

Magnitude: This is used to describe the geographic area or extent to which the language applies.

Duration: A measure used to describe how long lasting the impacts of the pathway are to habitat.

Intensity: This is a relative measure of the level of impact of benefit or harm to habitat not associated with geographic extent (magnitude), duration, or proximity to habitat.

General Working Rules

- Review each document by major paragraph or section. No more than one line item should be created in the worksheet for each major paragraph or section number. If necessary, analyze subsections collectively.
- Analyze, evaluate and document only what appears within the major paragraph or section (ignore references to other sections; they will have their own line item).
- When reviewing purpose statements, vision statements, policy goals, or research that can be considered directed at water quality or stream habitat but which does not establish a conveyance or pathway, a line item may be entered without scoring the item. Also, enter an item in the worksheet when a connection to water quality or stream habitat exists and a pertinent statement or goal is noticeably absent.
- When analyzing regulatory language, screen the statements carefully to identify any causal relationship between the statement and a pathway or conveyance.
- When screening policies, goals, or vision statements only include those that seem clearly directed at habitat, water quality, or specific pathways or conveyances,or statements that might unintentionally result in tangible impacts to water quality, habitat, or a pathway or conveyance.
- Generally, introductory statements, background information, and findings of fact should not be included in the worksheet, but relevant policies that result should be included.

- Make sure the pathway is analyzed in isolation; evaluate only the impact of one section at a time. For example, if impervious surface area must be reduced as a requirement for a landscape buffer, address only the reduction of impervious surfaces; do not address to the impacts that the landscape buffer might produce (e.g. application of horticultural chemicals, or other landscape management practices). Landscape management and maintenance requirements will be analyzed elsewhere.

- Use the hardcopy of the document as work record of notes, sketches and calculations. Record detailed rationale for analysis and scoring for future reference.

- When reviewing documents the following notations are suggested when screening statements:

  NA: Not applicable; this indicates that the section does not have a tangible connection to stream habitat.

  (i): This indicates that the section may have some relationship to habitat or water quality, but the connection is not tangible, or is inconsequential. For example, a policy statement to perform environmental plans or studies has no tangible benefit or impacts upon habitat, although there is an obvious relationship.

  CD: This indicates that the policy statement is a "Code Direction." If the Code has been reviewed, no entry should be made in the worksheet to avoid redundancy.

  REF: This indicates that the statement refers, authorizes, or directs another document. If the document is to be reviewed, do not make an entry in the worksheet. If not, research the reference and make an entry.

  Fringe: Indicates that the section pertains to areas outside the study area.

- Weight the impacts of overlay zones, conditional uses, and mixed-use zones that replace base zoning against the activities and uses it is likely to replace (e.g. commercial). Replacing commercial zoning with mixed-use zoning may eliminate the possibility of more intensive commercial uses.

Column Definitions

Line Reference Number: This column is used to record a sequential number for each section of code analyzed in the worksheet for cell reference purposes.

Document ID: This column is used to indicate the document being analyzed. A three-letter abbreviation is used (e.g. Corvallis Comprehensive Plan – CCP).

Impact Type: This column documents whether the impact pathway is **direct** or **indirect**. Direct impacts are those that directly impact stream habitat; for example, contaminants released directly into the waters of a salmon-bearing stream. Contaminants released on land, or those that enter stormwater systems would be indirect impacts.

Pathway/Conveyance: This column indicates the pathway or conveyance of the impact. Pathways should be classified as one of the following:

1. Channelization,
2. Impervious Surfaces,
3. Contaminants,
4. Barriers, or
5. Buffers.

Statements can be included in the worksheet that do not correspond to a specific pathway or conveyance. Either multiple pathways or conveyances may apply, or the statement may be too general to tie to a specific pathway or conveyance. In such cases the column should be used to indicate either "Multiple", or "Not Applicable" (NA).

+/-/0: This column is used to qualify the impact of the code section on habitat as, positive, negative, or neutral. For example, a code section with a positive impact might limit the amount of impervious surface allowed on sites within a zoning district.

Chapter Name: This column records the chapter name of the code in question.

Section Number: This column lists the specific code reference number being analyzed. When section numbers are not used, this column can be used to indicate a page number.

Section Name: This column lists the specific code name being analyzed.

Description: This is used to summarize the relevant content of the code section as follows:

First paragraph - code summary,

Second paragraph - conditions or exceptions, and

Third paragraph - list specific indicators or standards.

The "Description" column can include either a synopsis of the language within the section, a paraphrase, or a quotation.

Discussion/Justification: Enter in this column a formatted response to two key questions: 1) what is the relationship between the source use or activity, the pathway, and the habitat? and, 2) what is the rationale for scoring this specific pathway for the following parameters: +/-/0, Magnitude, Duration, and Intensity?

Filter: This column provides a useful way to categorize the language used in the code section (Definite or Conditional, Quantifiable or Non- Quantifiable): *Definite* - an absolute and universal requirement, or *Conditional* - a requirement that applies only under certain circumstances or when certain conditions have been met; and either as, *Quantifiable* - a statement or regulation with a clearly measurable effect, or *Non-quantifiable* - a statement that would not result in a measurable effect.

Magnitude: This column documents the geographic extent or scope of the code section. Magnitude is classified as Citywide (Score=3), Reach (Score =2), or Point (Score=1). "Point" means in only one location or on a site-by-site basis. "Reach" means the extent is less than citywide but in more than one place.

Duration: Duration is a temporal measure of how often or how frequently the pathway occurs or how often a pathway persists. Duration is classified as "Chronic" (Score=3), "Episodic" (Score=2), or a single event occurring only "Once" (Score=1).

Intensity: Intensity is an estimate of the level of impact to stream habitat. Estimates of intensity are High (Score=3), Medium (Score =2), or Low (Score=1). "Low" means little long-term harm to habitat. "High" means certain long-term harm to habitat. "Medium" means moderate impacts to habitat are likely to result.

Area: This column is reserved for later use, when some of the pathways can be quantified.

Subtotal: This column is a subtotal of scoring for Magnitude, Duration, and Intensity.

Total: This column indicates the total score based on subtotal and Weight.

CORVALLIS PATHWAYS AND REHABILITATION EVALUATION

This methodology has two parts. Part I sets the stage for the evaluation of impacts and the appropriate rehabilitation methods by using a more detailed assessment of the stream systems from a geographic and geomorphic standpoint. It uses an understanding of the urban setting of the stream basins, their function within the human-based infrastructure of the city, and the current habitat-forming processes to set the baseline for the last part.

Part II builds upon the scoring methodology developed in Phase 1 Pathways Analysis to provide the City with a tool for assessing the various options available for protecting, rehabilitating, and/or enhancing the current stream environment. This tool functions at the reach, stream, and watershed scales. This will eventually lead to the establishment of a trajectory of change toward achieving properly functioning condition within an urban stream network.

Quantification/Calculation Factors

The following stepped approach was used for the quantification/calculation for evaluating each reach for chinook salmon habitat.

1. Determine the stormwater basin for each area of interest. Using the basins listed below to organize the classification makes sense, in that the inputs to the streams fit into this model better than a strictly watershed-based system. This approach recognizes the urban reality of Corvallis' stream systems, and allows the classification to link the elements of the Stormwater Master Plan with the ESA baseline analysis conducted in Phase 1.

    a. Dixon Creek
    b. Dunawi Creek
    c. Jackson-Frazier-Village Green
    d. Sequoia
    e. Oak Creek
    f. Garfield
    g. Mary's River
    h. Willamette River

2. Select an appropriate reach (one of the three or more major subdivisions of the stream) and classify it using the geomorphic methodologies listed below. For the purposes of this analysis, the most important reach characteristic becomes simply the ability to define an area where processes appear to be acting in a similar fashion. Reaches are those used by the Salmon Response Plan to assess habitat. These reaches are based on geomorphologic changes such as the presence of tributaries entering the main stem and gradient

3. Determine the related land use/zoning for the area in question. This characteristic will guide the assessment of the impacts of the various pathways, and accentuate those that may have the most impact and eliminate those that may not have an effect. This also provides a structure for both restoration and for the use of best management practices (BMP). Zoning, for the purposes of the Salmon Response Plan, may be kept at a more coarse scale. A great many of the effects detected in the analysis conducted in Phase 1 are citywide in their scope, and so may be dealt with, for the purposes of this Plan, at this greater scale. The NOAA Fisheries is unlikely to want to evaluate City activities at a scale smaller than the reach level, with the exception of easily identified point sources. The tool being developed will provide the City with the framework for assessing impacts at the point source level, if desired.

    a. Residential
    b. Agricultural
    c. Commercial
    d. Municipal
    e. Industrial

4. Determine listed fish use. This establishes the baseline for evaluation of the impacts of pathways on listed populations, and also provides input into the rehabilitation decision tree elements of the plan. Habitat types of interest include spawning habitat, rearing habitat, refugia, and movement corridors. Spawning habitats generally consist of riffle or pool tail-out areas with a high percentage of gravel substrate. Rearing habitat consists of moderate-sized pools with overhead cover. Barriers include impassable culverts, pop-up or other dams, and de-watered areas. Other elements of habitat directly influenced by city activities include temperature, turbidity, and food supply.

    a. Spawning. Depth, velocity, and size of redd area are highly variable. The key requirement is large gravel. Chinook have been known to clean and spawn in areas containing as much as 25% fine sand/silt/clay substrates.

    b. Rearing. Rearing generally occurs in smaller tributaries, using well-developed riffle-pool systems with rubble type habitat. Chinook tend to avoid rearing in beaver ponds or off-channel sloughs.

    c. Movement. The key element in movement is to ensure passage at times when listed species may be using a stream. Blockage factors include direct blockages such as pop-up dams and compromised or poorly designed culverts.

    d. Refuge from high-water winter flows. Access and water quality comprise the critical issues here.

5. Identify any habitat-forming processes in stream.

    a. Floodplain/groundwater connectivity (level of incision and overland flow). Does the stream still overflow its banks? Are there streamside wetlands present? Is there still a connection with the groundwater system, both laterally and vertically?

    b. Hydrograph. Do 2-year floods occur with a 1.5- to 3-year periodicity? Is the major contributor to year-round flows groundwater-based, such that the rising limb of the hydrograph is smaller than would be the case if the major contribution came from directed flow or overland flow? What level of floodplain water storage is available?

    c. Riparian community structure, width, and connectivity. Communities should be dominated by native species and should be a mosaic of the various seral stages and sizes appropriate for that area. Indications of non-functioning or impaired functioning include: riparian areas missing entirely or broken up by large areas of infrastructure impingement; communities heavily dominated by non-native vegetation and climax or early seral stages (should be a mosaic which would adequately represent levels of disturbance necessary to maintain the stream in a dynamic equilibrium); reduced or no capability for large wood supply to the stream, and leafy debris in the upper reaches.

d. Pool-riffle ratios, reach-specific. Existing pools should be deep and broken up by riffle areas, rather than taking on the form of glides. The presence of glides suggests a system that is on a trajectory away from properly functioning condition.

e. Substrate type. This depends upon the soils and bedrock present. Some reaches degrade more rapidly than others (i.e., reaches higher up in the system with greater gradients), and so contain larger substrates. Fines should dominate aggrading reaches, lower down in the system with little or no gradient. Fines dominate not properly functioning systems. When gravels are present, they are heavily imbedded or low in the system, indicating high flows sufficient to transport bedload.

f. Instream cover. –The presence of undercut banks, instream boulders, and woody debris.

SCORING AND RANKING METHODOLOGY

The following is the description of the pathway/effects analysis used to determine the impact of city services and citizen behavior on chinook salmon habitat. The first part is the development of the pathways/effects database in the first phase of the project. The second part is the combining of the baseline conditions data and pathways/effects database in the second phase of the project into a powerful tool that allows the City to identify the geographic distribution and the degree of impact that City services and citizen behavior have on chinook salmon habitat. This weighted database was developed using relational database software, which can access, query and analyze large data sets (the weighted dataset has approximately 4,300 records). From this weighted database the City is able to rank impacts to chinook salmon habitat and develop a list of priority remedial actions.

Pathways/effects weighted database covers the following activities and citizen behavior:

- Public infrastructure activities and operations and maintenance
  - Wastewater treatment
  - Water supply
  - Stormwater management
- Transportation activities and routine road maintenance
- Planning activities
  - Comprehensive Plan
  - Zoning
  - Land Development Code
- Parks and recreation activities and operations and maintenance
- Fire Department training and vehicle/equipment maintenance

- Public construction specifications
- Citizen behavior (household and yard maintenance activities, landscaping, home auto repair, etc.)

Scoring process

Priority ranking of City programs and activities was based on the scores as discussed above. Using the stormwater basin for each area of interest recognized the urban reality of Corvallis' stream systems. Using reaches as defined by the riparian analysis recognized the changes in streams resulting from urbanization and solves the problem of reach definition characteristics. For the purposes of this analysis, the most important reach characteristic becomes simply the ability to define an area where processes appear to be acting in a similar fashion.

The use of a methodology for scoring impacts and evaluating projects allowed the City to make determinations as to the most important elements to fulfill its various mandates (e.g., ESA, Clean Water Act, Statewide Planning Goals). This methodology assumed that funds for rehabilitation are not limitless, and there is a desire to accomplish the necessary ordinance changes in as few steps as possible. The approach provided a mechanism for evaluating effects on any level desired by the City, as well as erecting a framework for fiscal analysis.

Pathways/Effects Analytic Approach

1. Determine the pathway(s) of interest and operating in the selected area. For the City of Corvallis, Contaminants and Buffers are the major pathways for habitat degradation in all reaches and all systems for the purpose of ESA compliance. The following are the pathways (see detailed discussion in earlier part of this chapter).

    a. Channelization/Instream Habitat

    b. Impervious Surface

    c. Riparian Areas/Buffers

    d. Barriers

    e. Contaminants

2. Determine the latitudinal/longitudinal extent of the pathway.

    a. Within the riparian buffer/floodplain (3). Activities occurring within this zone have the capability of influencing the listed fish and their habitat with less need for a transport mechanism such as the stormwater system. Activities within this area also directly affect the riparian buffer characteristics.

b. Outside the buffer/floodplain (1). This is scored lower simply because activities occurring outside the buffer require the intervention of a transport mechanism (such as the stormwater system).

3. Rank the location of the pathway or event (by reach and stormwater basin). Each system should be weighted according to the pathway of interest. The Contaminant pathway should be the same for all streams, regardless of their position in the system, as should the riparian buffer (for purposes of water quality). Impervious surface and instream habitat should use the ranking system listed below. The importance of the Buffer pathway varies with the desired function. The most important functions of the buffer are to maintain water quality. Buffer width should increase in a downstream direction, as the amount of flow increases and the gradient decreases to the point that the stream can easily overflow its banks. Barriers should be addressed going upstream, with the greatest emphasis on those lower in the system.

    a. Upland tributaries: urbanized (4), non-urbanized (5)

        i. Intermittent stream area (2)

        ii. Perennial stream area (4)

    b. Non-urbanized lowlands (2)

    c. Urbanized lowlands (1)

4. Determine the spatial extent (magnitude) of the pathway's influence. Spatial extent plays an important role not only in the assessment of the level of influence, but also on the nature of the restorative or rehabilitative activity. The greater the magnitude, the more likely that fixes will require some change in ordinances or the creation of new ones. This does not preclude the use of individual or point-related BMP.

    a. Point. Occurring at a single location or site (1).

    b. Reach. Occurring at multiple locations throughout the designated stormwater reach (2).

    c. Reach. Occurring at multiple locations throughout the designated ESA survey reach (3)

    d. Basin/Watershed. Occurring throughout the basin as a whole (4).

5. Determine the timing (Duration) of the pathway. Timing has considerable influence upon the resilience of the system. Historic habitat-forming processes tended to be single-event or episodic in nature. The chronic nature of a great many anthropogenic changes in inputs to these processes is considered to apply more stress to the ability of the system to rebound.

    a. Single event (1) - occurs as the result of failure to implement BMPs or failure of BMPs.

b. Episodic (2) - intervals are regular but occurs more than once
c. Chronic (4) - occurs as the result of long-term action (e.g. stormwater runoff
d. Periodic (3) - occurs at regular intervals

6. Determine intensity of the pathway or event. Intensity of an activity is related, to some degree, to the previous two categories (magnitude and duration) and has the least clear-cut predictive capability.

    a. Low (1) - little or no mortality or habitat change expected
    b. Medium (2) - some mortality; habitat changes occur but are within the resilience capability of the stream and within expectations for that particular time period in the evolution of the stream
    c. High (4) - dramatic changes beyond the capability of the reach or stream to accommodate, forcing a change in steam geomorphology beyond that which could be expected from typical stream evolution; sufficient mortality to put populations in that area in jeopardy

The scoring methodology determines the pathway(s) of interest and operating in that area and the latitudinal/longitudinal extent of the pathway. It is then assessed as to its position within or outside the riparian buffer/floodplain, and ranked by the location of the pathway or event (by reach and basin). Next, it evaluates instream habitat and presence of impervious surface by reach longitudinal position and physiographic characteristics. Finally, it evaluates the spatial extent (magnitude, duration, and intensity) of the pathway's influence.